








Additions of host associations and new records of bat ectoparasites of the families Spinturnicidae, Nycteribiidae and Streblidae from Honduras

Gustavo Graciolli¹, Hefer D. Ávila-Palma^{2,3}, Eduardo J. Ordoñez-Trejo^{2,4}, José A. Soler-Orellana², Diego I. Ordoñez-Mazier², Marcio Martínez^{2,5}, Richard LaVal⁶, Manfredo A. Turcios-Casco^{2*}

1 Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Campo Grande, Brazil • GG: ggraciolli@yahoo.com.br  <https://orcid.org/0000-0002-1144-3486>

2 Asociación para la Sostenibilidad e Investigación Científica en Honduras, Comayagüela, Francisco Morazán, Honduras • HDAP: hefer.avila77@gmail.com  <https://orcid.org/0000-0002-7098-7635> • EJOT: edu.ordnz03@gmail.com  <https://orcid.org/0000-0002-8543-5235> • JASO: biacuya00@yahoo.com  <https://orcid.org/0000-0002-4175-0751> • DIOM: diegoivano@yahoo.com  <https://orcid.org/0000-0001-6285-662X> • MM: sphyrnam@yahoo.es  <https://orcid.org/0000-0003-3307-6848> • MATC: manturcios21@gmail.com  <https://orcid.org/0000-0002-3198-3834>

3 Panthera Corporation, Tegucigalpa, Francisco Morazán, Honduras

4 Escuela de Biología, Universidad Nacional Autónoma de Honduras, Boulevard Suyapa, Tegucigalpa, Francisco Morazán, Honduras

5 Región Biosfera del Río Plátano, Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre, Marañones, Olancho, Honduras

6 The Bat Jungle, Monteverde, Costa Rica • RLV: rklaval@gmail.com  <https://orcid.org/0000-0001-7726-9882>

* Corresponding author

Abstract

We captured mormoopids, phyllostomids, and vespertilionids in Honduras to collect bat ectoparasites. Two species of Spinturnicidae (Acari) are the first reports of this family in Honduras. One species of *Basilia* Miranda Ribeiro, 1903, and four of Streblidae are recorded for the first time in Honduras. With these results, the current species number of each family for Honduras are two species of Spinturnicidae, three of Nycteribiidae, and 48 of Streblidae. We compared the number of species of Streblidae and bats in Honduras to highly sampled countries in Central and South America. Clearly, more effort is still needed in Honduras, although this is the third attempt to study the bat ectoparasites in Honduras.

Keywords

Bat flies, Central America, distribution, ectoparasites, mites

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Introduction

Bats are the order of mammals with the second largest number of species (>1,400 species) (Simmons and Cirranelo 2020). As the only mammals capable of flight, they have a worldwide distribution, except Antarctica. Bats harbor a diverse community of ectoparasitic arthropods (Marshall 1981; Whitaker et al. 2009), with some groups occurring exclusively on them. Among these, the most frequent groups found on bats are wing mites of the family Spinturnicidae (Acari) and bat flies of the families Streblidae and Nycteribiidae (Diptera).

Spinturnicid mites are viviparous, hematophagous, and pass their entire life cycle on bats (Dowling 2006). There are five genera and 40 species of spinturnicids recorded in the Americas, collected on bats of the families Vespertilionidae, Phyllostomidae, Mormoopidae, and Natalidae (Dusbábek 1968; Almeida et al. 2016). Previous to this work, there were no records of spinturnicid mites from Honduras. As for other countries of Central America, the accounts are as follows: 15 species in Panama, 14 species in Mexico, one in Belize, and five in Costa Rica (Herrin and Tipton 1975; Almeida et al. 2016).

In the Americas, there are 166 species of 26 genera of streblid bat flies divided into three subfamilies (Dick and Miller 2010; Graciolli and Azevedo 2011; Graciolli and Dick 2012; Reeves et al. 2013; Alcántara et al. 2019). Streblid bat flies occur on Phyllostomidae, Mormoopidae, Noctilionidae, Natalidae, Vespertilionidae, and Molossidae (Dick and Miller 2010). For Honduras, Dick (2013) summarized a total of 43 species and 17 genera of Streblidae, collected from nine of the 18 Honduran departments. After his work, there has been only one more study reporting bat flies from Honduras (Miller 2014), collected in Utila, Islas de la Bahía in northern Honduras, with a new record for the country, *Trichobius angulatus* Wenzel, 1976. This brings the total number of species to 44.

For Nycteribiidae, there are two genera from the Americas: *Basilia* Miranda-Ribeiro, 1903 with 55 species, divided into five morphological groups that are mainly found on vespertilionid bats (Graciolli 2010). However, two species are found on bats of the genus *Gardnerycteris* Hurtado & Pacheco, 2014. *Herschkovitzia* Guimarães & D'Andretta, 1956 has four species that parasitize bats of the family Thyropteridae (Graciolli et al. 2007; Graciolli and Dick 2009; Graciolli 2010). There are also few species recorded for the countries adjoining Honduras. Thus, two species of *Basilia* for Belize, three species for Guatemala, and five species each for El Salvador and Nicaragua. Only two species of *Basilia* had been reported for Honduras, *B. rondanii* Guimarães & D'Andretta, 1956 and *B. dubiaquercus* Graciolli & Dick, 2009 (Graciolli et al. 2007; Graciolli and Dick 2009).

Here we report for the first time for Honduras the family Spinturnicidae based on two species, as well as a new record of Nycteribiidae and four new records of

Streblidae for the country. Also, we give ecological comments on the ectoparasites and their hosts.

Methods

We captured bats with two mist nets (12 × 2.5 m with denier mesh of 35 mm) that were set at ground level and opened from 17:20 to 01:30 h. Their position at each site was selected based on the surrounding vegetation and topography, and also considering water bodies, if available, and fruiting and flowering plants (Kunz and Kurta 1988). All the bats were manipulated according to the guidelines for the use of mammals in wildlife research (Sikes et al. 2019).

We used forceps to remove all ectoparasites in the field and placed them in vials containing 70% ethanol. The ectoparasites were identified in the laboratory using keys for American streblid bat flies of Wenzel et al. (1966), Wenzel (1976), and Guerrero (2019); nycteribiid bat flies were identified based on Guimarães (1977) and Graciolli (2004); and spinturnicid mites were identified according to Herrin and Tipton (1975). All the specimens were deposited at the Zoological Collection at Federal University of Mato Grosso do Sul (ZUFMS). Collecting license (Resolución-DE-MP-064-2017) and exportation permit (Constancia ICF-DVS-27-2017) was provided by the Wildlife Department of the Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre (ICF).

Results

Two species of *Periglischrus* (Spinturnicidae), one of *Basilia* (Nycteribiidae), and one each of the streblid genera *Aspidoptera* Coquillett, 1899, *Neotrichobius* Wenzel & Aitken, 1966, *Strebla* Wiedemann, 1984, and *Trichobius* Gervais, 1844 are recorded for the first time in Honduras. The new records in separate localities increase the number of species of *Basilia* to three and of Streblidae to 48 species (Fig. 1). In overall we describe seven new records of bat ectoparasites and 12 hosts for Honduras.

Spinturnicidae

Periglischrus iheringi Oudemans, 1902

Material examined. HONDURAS • Francisco Morazán, Ciudad Universitaria; 14°05'14"N, 087°09'60"W, 1100 m a.s.l.; 19 Nov. 2015; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, Eduardo J. Ordoñez-Trejo, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; the host was *Artibeus jamaicensis* Leach, 1821; 1 ♀, ZUFMS-ART2361.

Identification. The females of *Periglischrus iheringi* (Fig. 3A) can be identified by having the sternal setae longer; the first pair extending to or beyond the level of the second pair of setae; the intercoxa IV area has eight pairs of setae; and because the proximal anterior and posterior dorsal setae are longer and subequal in length (Herrin and Tipton 1975).

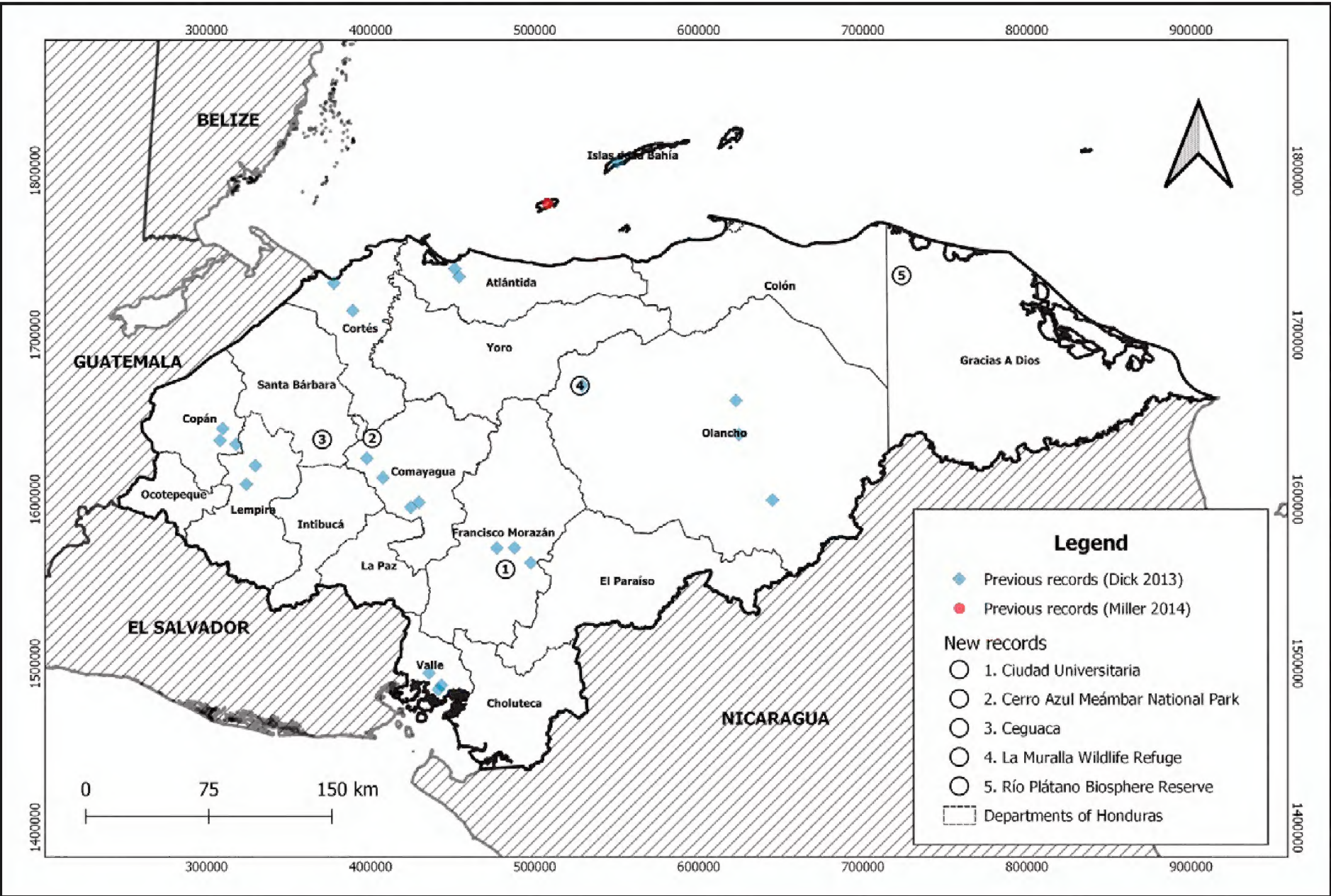


Figure 1. Study sites and sites mentioned by Dick (2013) and Miller (2014).

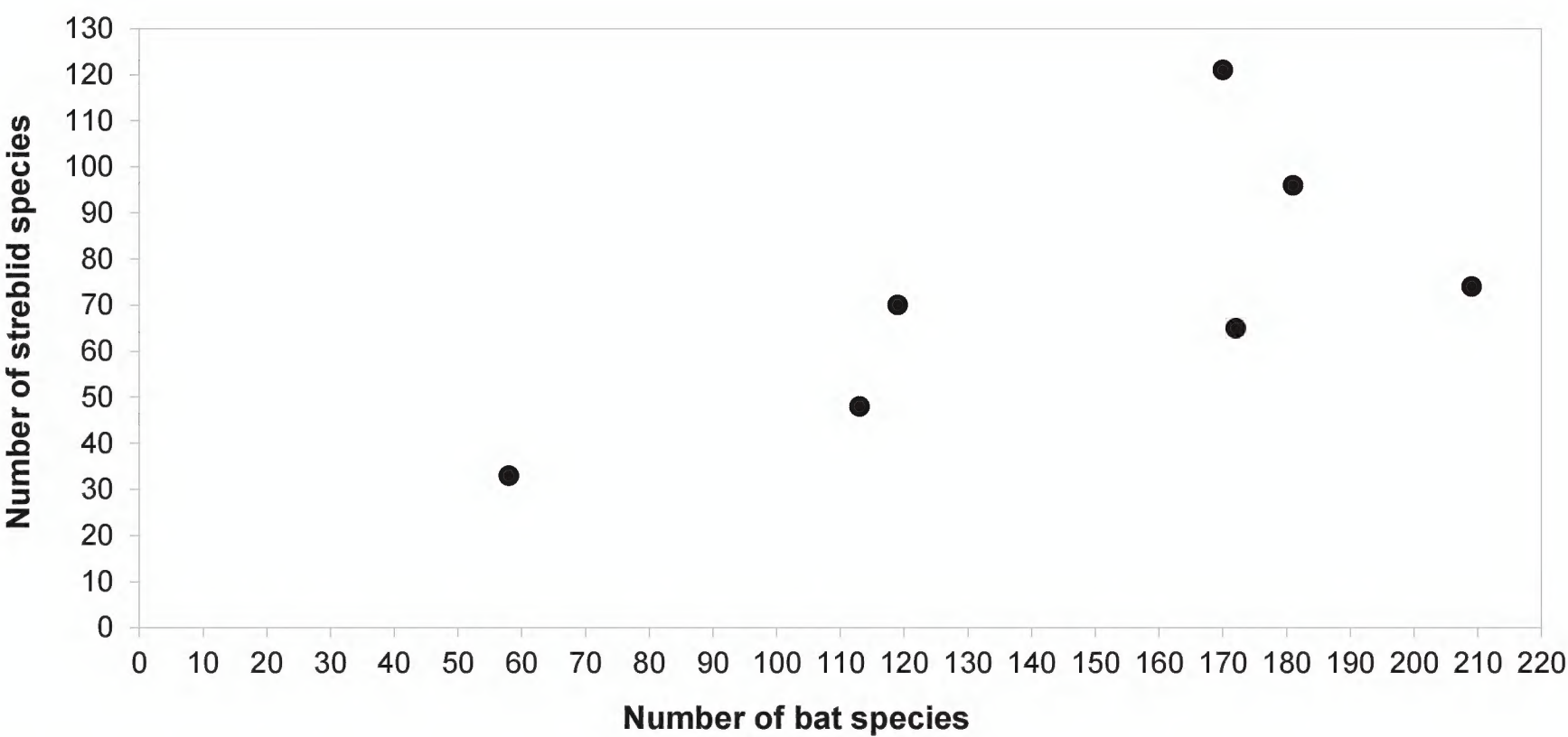


Figure 2. Number of species of Streblidae and Chiroptera in Central and South America according to Table 1.

Table 1. Number of species of Chiroptera and of Streblidae in Brazil, Colombia, Honduras, Panama, Paraguay, Peru, and Venezuela.

Country	Number of bat species	Source	Number of streblid species	Source
Colombia	209	Ramírez-Chaves et al. 2020	74	Marinkelle and Grose 1981; Dick et al. 2016
Brazil	181	Garbino et al. 2020	96	Graciolli 2020
Peru	172	Díaz et al. 2016	65	Guerrero 1996b; Autino et al. 2011
Venezuela	170	Díaz et al. 2016	121	Wenzel 1976; Guerrero 2019
Honduras	113	Turcios-Casco et al. 2020	48	Dick 2013; Miller 2014, this study
Panama	119	Estrada-Villegas et al. 2018	70	Wenzel et al. 1966
Paraguay	58	De la Sancha et al. 2017	33	Dick and Gettinger 2005

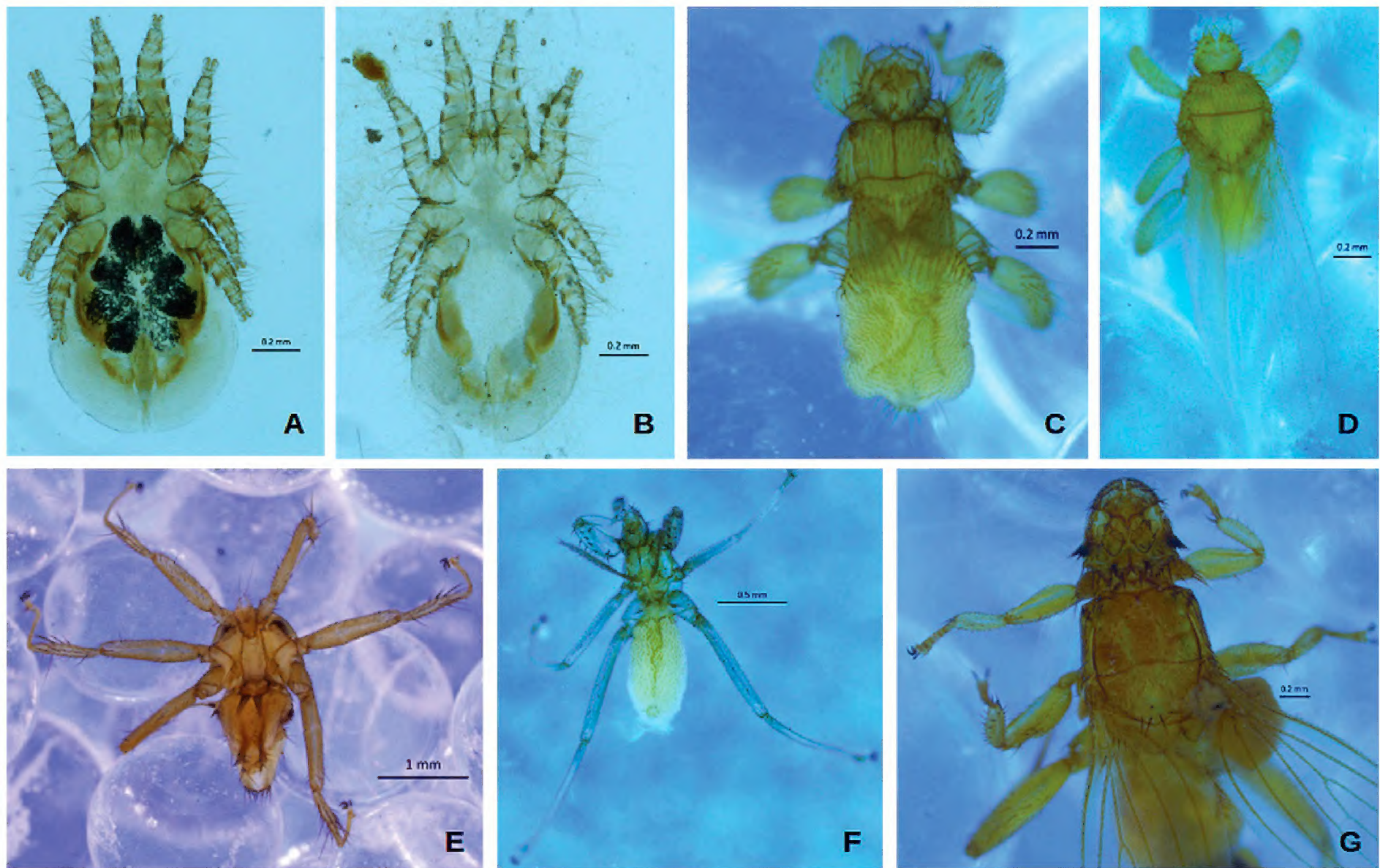


Figure 3. Species of ectoparasites recorded for the first time in Honduras. **A.** *Periglischrus iheringi* Oudemans (Spinturnicidae). **B.** *Periglischrus ojastii* Machado-Allison (Spinturnicidae). **C.** *Aspidoptera delatorrei* Wenzel (Streblidae). **D.** *Trichobius yunkerii* Wenzel (Streblidae). **E.** *Basilia ortizi* Machado-Allison (Nycteribiidae). **F.** *Neotrichobius bisetosus* Wenzel (Streblidae). **G.** *Strebla matsoni* Wenzel (Streblidae).

Remarks. Previously, *Periglischrus iheringi* was recorded in Bolivia, Brazil, Colombia, Costa Rica, Cuba, Mexico, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts, Suriname, Trinidad and Tobago, and Venezuela (Dusbábek and Lukoschus 1971; Beck et al. 2016; Gettinger 2018) (Fig. 4). *Periglischrus iheringi* is found on various species and genera of stenodermatine bats (Herrin and Tipton 1975; Gettinger 2018) but occur mainly on bats of the genera *Artibeus* Leach, 1821, *Platyrrhinus* Saussure, 1860, and *Uroderma* Peters, 1865 (Herrin and Tipton 1975).

***Periglischrus ojastii* Machado-Allison, 1964**

Material examined. HONDURAS • Francisco Morazán, Ciudad Universitaria; 14°05'14"N, 087°09'60"W, 1100 m a.s.l.; 19 Dec. 2015; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, Eduardo J. Ordoñez-Trejo, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; the hosts were *Sturnira parvidens* Goldman, 1917; 1 ♀, ZUFMS-ART2362; 1 ♂, ZUFMS-ART2363.

Material examined. HONDURAS • Comayagua, Cerro Azul Meámbar National Park, Cerro Azul Community; 14°48'19"N, 087°55'21"W; 965 m a.s.l.; 10 May 2016; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; the host was *S. parvidens*; 1 ♀, ZUFMS-ART2364.

Identification. *Periglischrus ojastii* (Fig. 3B) can be identified by having the first pair of dorsal podosomal setae of females subequal in length to the other podosomal

setae located on the anterolateral integument of the dorsal plate. In both sexes the distance between the first and second pairs of podosomal setae is distinctly less than the distance between the second and third pairs. The posteroventral setae of femur IV, patella IV, and tibia IV are straight and bladelike in females (Herrin and Tipton 1975).

Remarks. Previously *P. ojastii* was recorded in Brazil, Bolivia, Colombia, Costa Rica, Dominica, Mexico, Panama, Peru, and Venezuela (Dick et al. 2007; Gettinger 2018) (Fig. 5). This species is, in general, found on bats of the genus *Sturnira* Gray (Gettinger 2018).

Nycteribiidae

***Basilia ortizi* Machado-Allison, 1964**

Material examined. HONDURAS • Gracias a Dios, Río Plátano Biosphere Reserve World Heritage Site, Las Marías, Las Marías Pesh Tribal Council; 15°40'32"N, 084°50'35"W, 33 m a.s.l.; 02 Sept. 2017; Hefer D. Ávila-Palma, Diego I. Ordoñez-Mazier, Marcio Martínez leg.; the hosts were *Eptesicus furinalis* (d'Orbigny, 1847); 1 ♂, ZUFMS-ART2365; 1 ♀, ZUFMS-ART2366.

Identification. *Basilia ortizi* (Fig. 3E) belongs to the *feruginea* group. The females have two abdominal tergites, and the second one has a posterior margin with two lobes. *Basilia ortizi* can be recognized by having a digitiform process in the mesonotum; an abdominal connexivum with shorter setae; and the lobules of tergite II are longer than wider, with one to three long spiniform setae

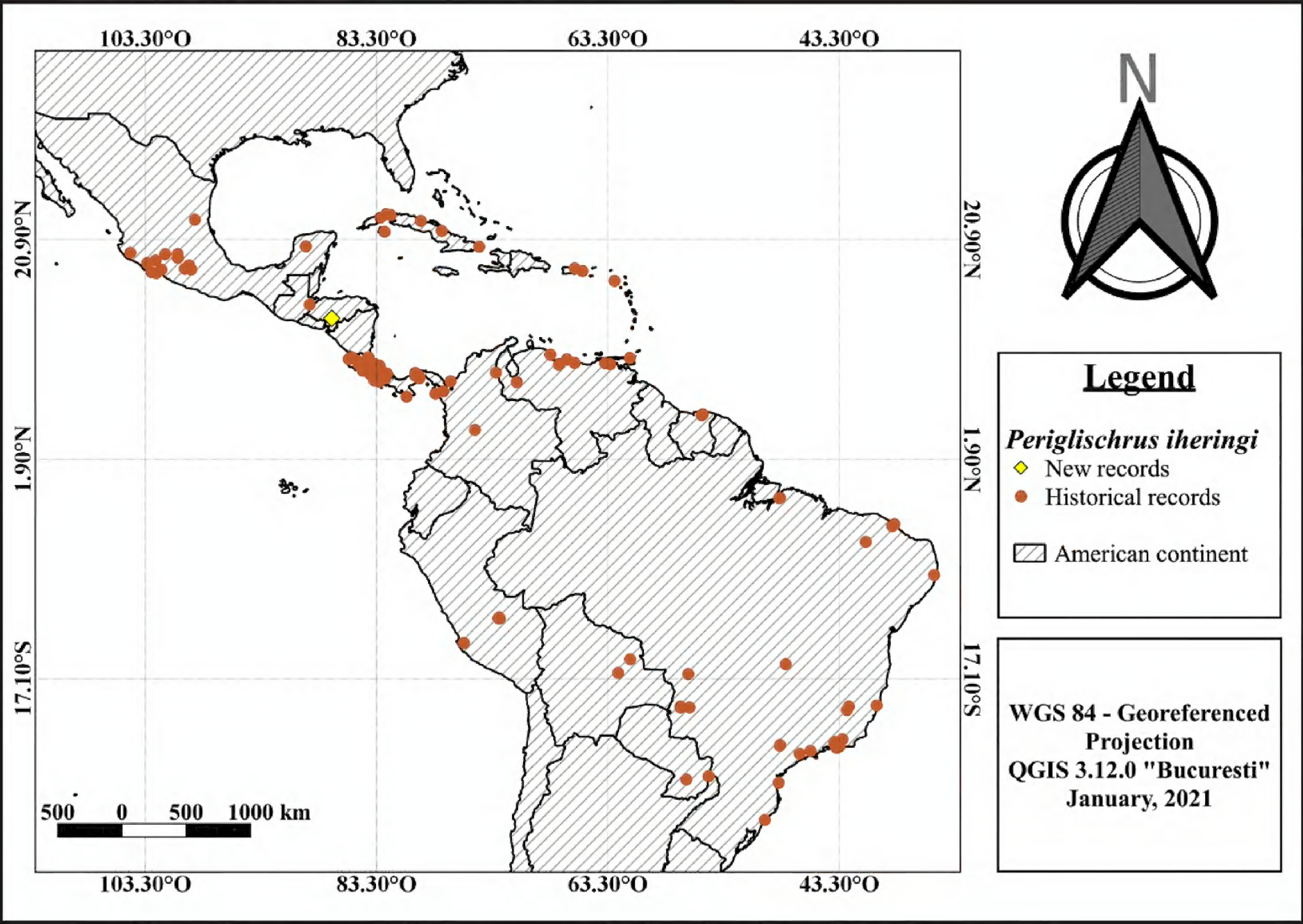


Figure 4. Historical and new records of *Periglischrus iheringi* in the Americas.

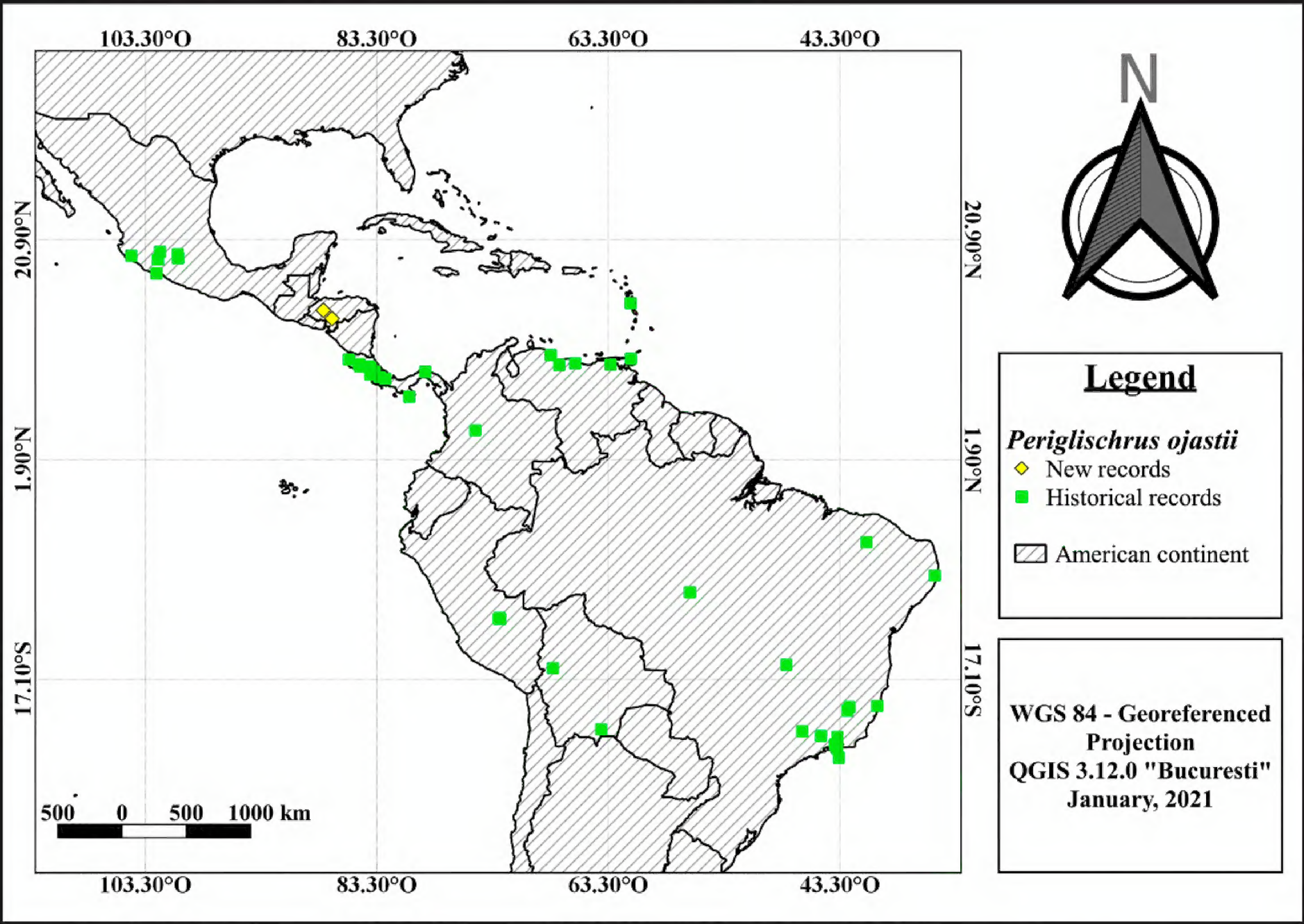


Figure 5. Historical and new records of *Periglischrus ojastii* in the Americas.

and one to seven short spiniform setae (Guimarães 1977; Graciolli 2004).

Remarks. *Basilia ortizi* was previously recorded in Belize, Costa Rica, French Guiana, Venezuela, and Brazil (Graciolli et al. 2007; Graciolli et al. 2019) (Fig. 6) and found on *Enchisthenes hartii* (Thomas, 1892), *Eptesicus brasiliensis* (Desmarest, 1819), *E. diminutus* Osgood, 1915, *E. furinalis*, *Myotis nigricans* (Schinz, 1821), and *M. riparius* Handley, 1960 (Graciolli et al. 2007; Urbietta et al. 2018).

Streblidae

Aspidoptera delatorrei Wenzel, 1966

Material examined. HONDURAS • Comayagua, Cerro Azul Meambar National Park, Cerro Azul Community; 14°48'19"N, 087°55'21"W; 965 m a.s.l.; 10 May 2016; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; the hosts were *Sturnira parvidens*; respectively, 1 ♀, ZUFMS-ART2367; 1 ♂, ZUFMS-ART2368.

Material examined. HONDURAS • Olancho, La Murralla Wildlife Refuge; 15°05'48"N, 086°44'41"W; 1486 m a.s.l.; 21 Apr. 2017; Hefer D. Ávila-Palma leg.; host was *Sturnira hondurensis* Goodwin, 1940; 1 ♂, ZUFMS-ART2369.

Identification. *Aspidoptera delatorrei* (Fig. 3C) can be differentiated from *A. phyllostomatis* Perty, 1833 because

the latter has a smaller mesepisternum (seen from dorsal view), and from *A. falcata* Wenzel, 1976 because the former has two epiproct setae and less curved gonopods (Guerrero 1994b).

Remarks. Previously, *A. delatorrei* was recorded in Belize, Colombia, Guatemala, Mexico, Nicaragua, Panama, Peru, and Venezuela (Guerrero 1994a; ter Hofstede et al. 2004) (Fig. 7). It is mainly found on bats of the genus *Sturnira* (Guerrero 2019).

Neotrichobius bisetosus Wenzel, 1976

Material examined. HONDURAS • Gracias a Dios, Río Plátano Biosphere Reserve World Heritage Site, Pico Dama, Las Marías Pesh Tribal Council; 15°41'39"N, 084°54'56"W; 383 m a.s.l.; 08 Sept. 2017; Hefer D. Ávila-Palma, Diego I. Ordoñez-Mazier, Marcio Martínez leg.; host was *Vampyressa thylene* Thomas, 1909; 1 ♀, ZUFMS-ART2370.

Identification. Individuals of *N. bisetosus* (Fig. 3F) can be differentiated from *N. delicatus* and *N. ectophyllae* because in *N. bisetosus* the second vein does not reach the apex and only extends, like a spur, a little beyond from the r-m; in *Neotrichobius stenopterus* Wenzel & Aitken, 1966 there are four scutellar setae.

Remarks. *Neotrichobius bisetosus* is the second species of its genus recorded in Honduras; the first is *N. stenopterus*. *N. bisetosus* was previously known for Bolivia, Brazil, Colombia, French Guiana, Panama, Peru,

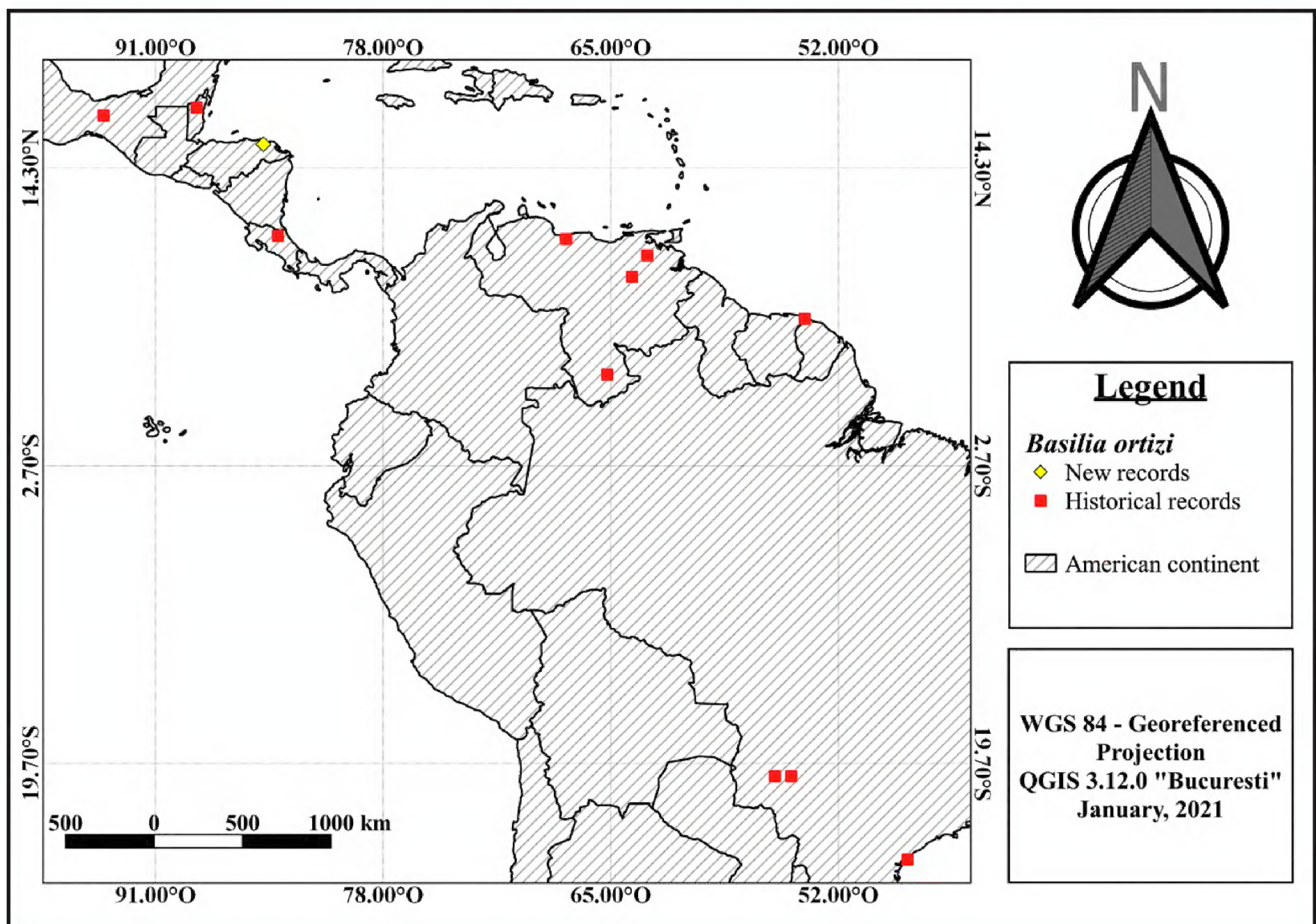


Figure 6. Historical and new records of *Basilia ortizi* in the Americas.

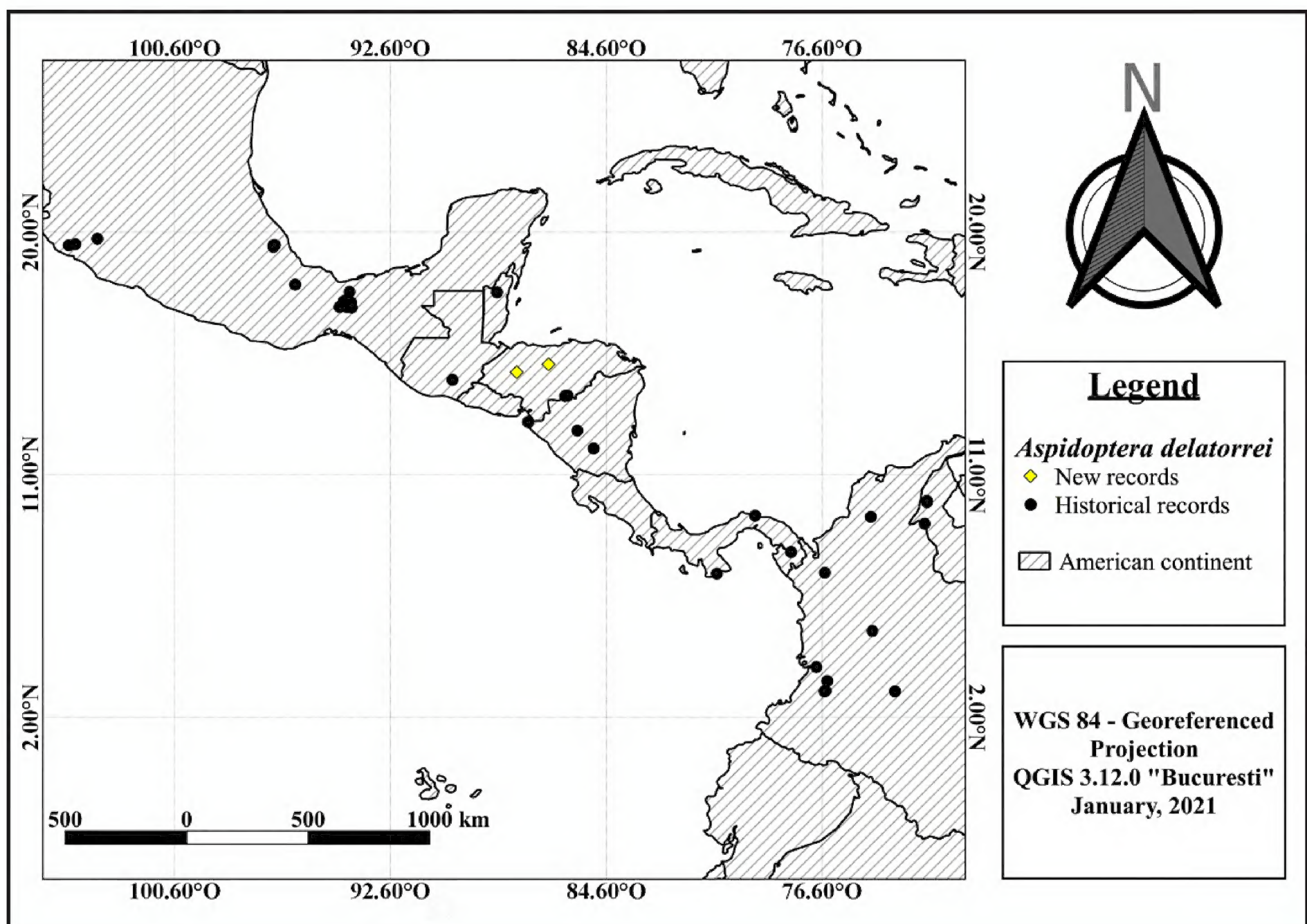


Figure 7. Historical and new records of *Aspidoptera delatorrei* in the Americas.

Suriname, and Venezuela (Dick et al. 2016; Graciolli et al. 2019; Guerrero 2019; Hrycyna et al. 2019) (Fig. 8). The main host of *N. bisetosus* is *Artibeus obscurus* (Schinz, 1821) (Guerrero 2019), but it had been found on other species of *Artibeus*, *Phyllostomus hastatus* (Pallas, 1767), and a natalid bat, *Natalus stramineus* Gray, 1838 (Guerrero 2019). This is the first record on *V. thyone*, and we consider this association with this bat species to be accidental or transitory

***Strebla matsoni* Wenzel, 1976**

Material examined. HONDURAS • Santa Bárbara, Área de Importancia para la Conservación de Murciélagos Ceguaca, Mujer de los Juncos; 14°47'50"N, 088°12'19"W; 515 m a.s.l.; 21 Dec. 2015; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, Eduardo J. Ordoñez-Trejo, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; host was *Artibeus jamaicensis*; 1 ♀, ZUFMS-ART2371.

Identification. *Strebla matsoni* (Fig. 3G) can be identified by its frontoclypeus, which has a pair of apical plates that are separated from the anterior border; although large, it is difficult to see (Guerrero 1996a). Eyes with eight facets. Post-vertex with short, thin setae, especially the internal occipital plates, which are very short; anterior end pointed, with an angle of approximately 120° (Guerrero 1996a). Mesonotum without visible spaces; row before the pigmented suture, and setae equal to or slightly longer than the rest giving a very uniform appearance;

with three rows of setae between the transverse suture and the pigmented suture (Guerrero 1996a).

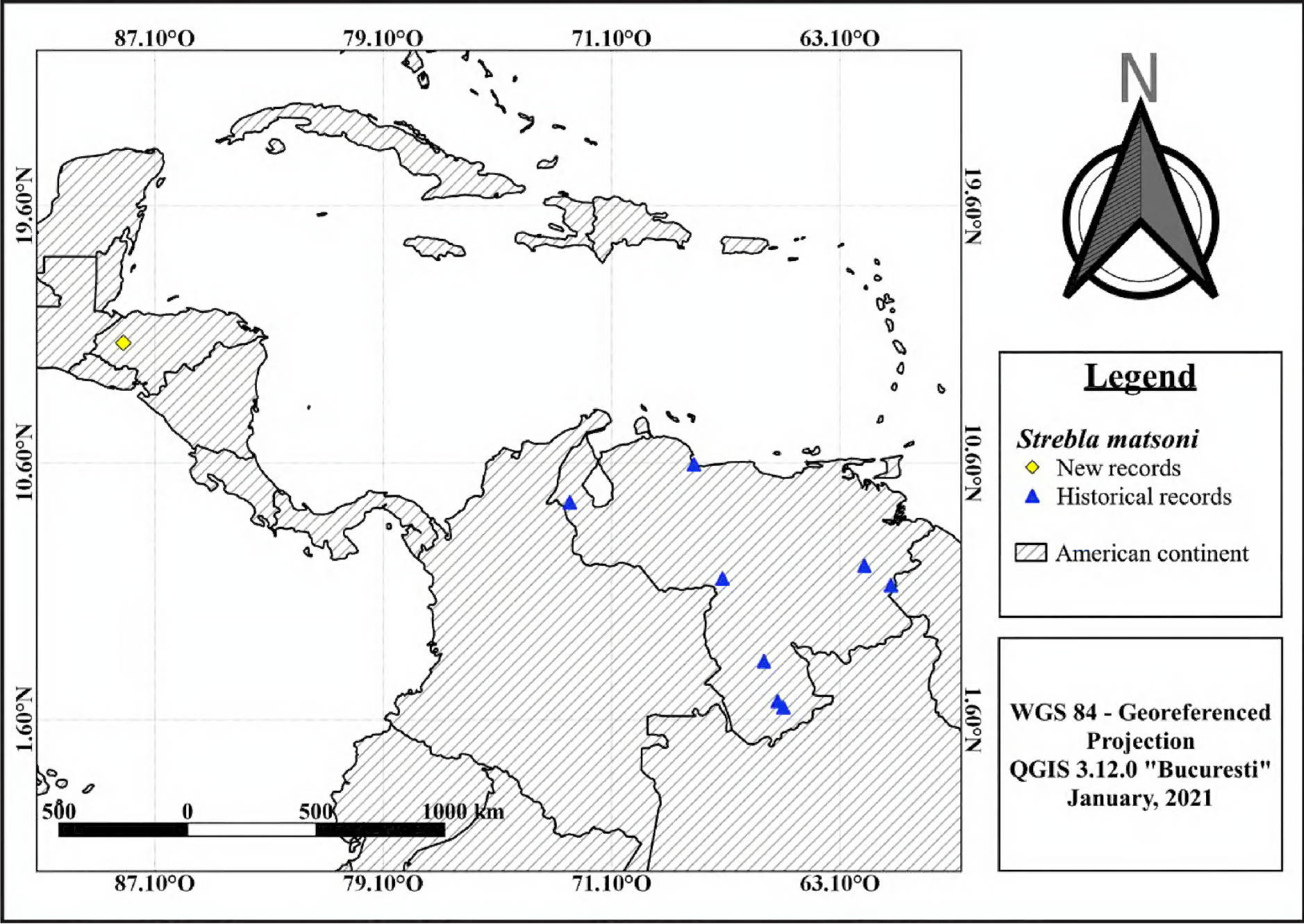
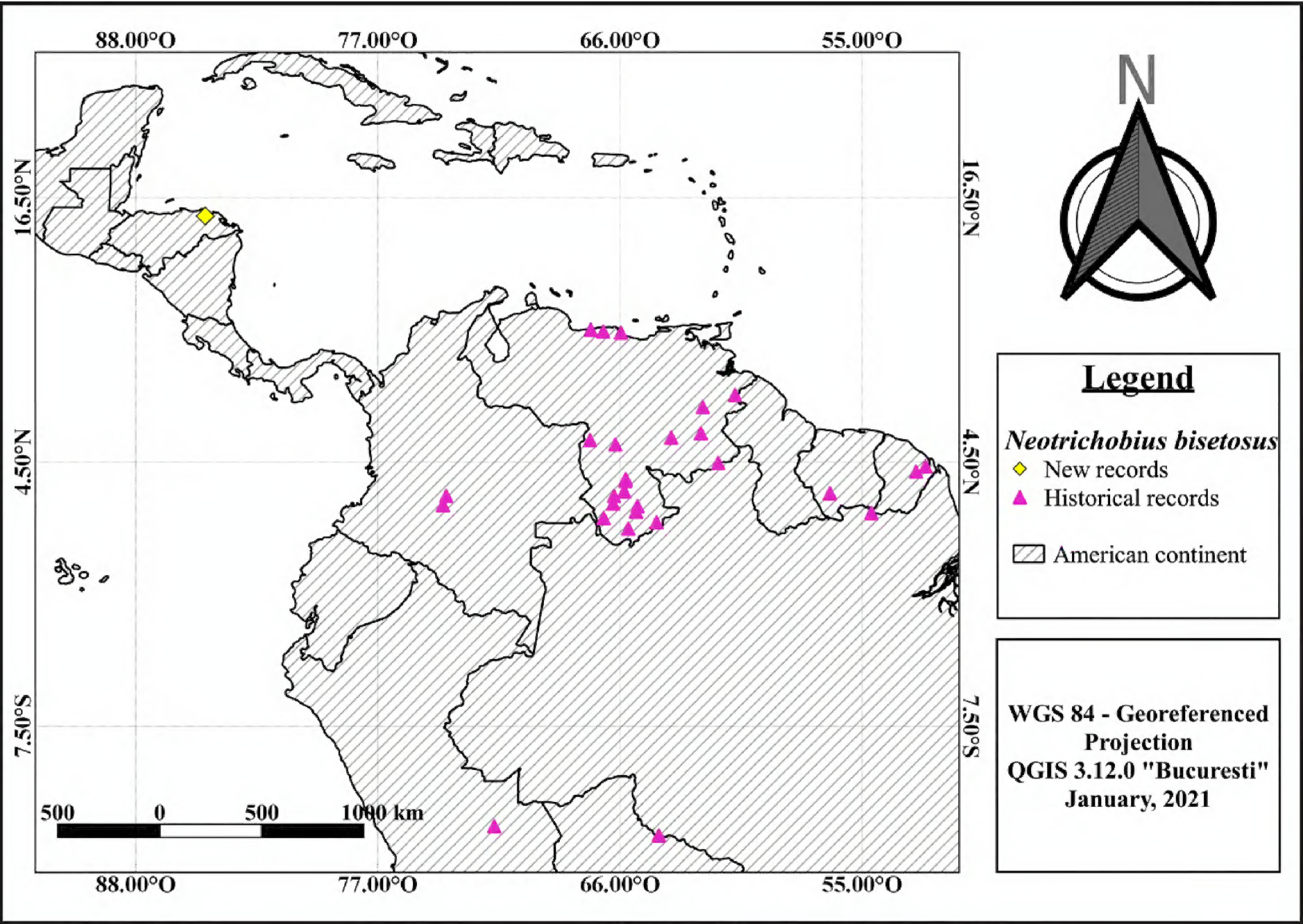
Remarks. This is often considered a rare species of *Strebla* (Guerrero 1996a). The only known collected specimens of this species were the type material which consists of two males and one female from Venezuela (Fig. 9). The previous records were collected on *Macrophyllum macrophyllum* (Schinz, 1821), *Carollia perspicillata* (Linnaeus, 1758) (Phyllostomidae), and *Rhynchonycteris naso* (Wied-Neuwied, 1820) (Emballonuridae) (Guerrero 1996a, 1996b). Thus, *A. jamaicensis* is recorded for the first time as a host of *S. matsoni*.

***Trichobius yunker* Wenzel, 1966**

Material examined. HONDURAS • Comayagua, Cerro Azul Meámbar National Park, Cerro Azul Community; 14°48'19"N, 087°55'21"W; 965 m a.s.l.; 09 May. 2016; Manfredo A. Turcios-Casco, Hefer D. Ávila-Palma, José A. Soler-Orellana, Diego I. Ordoñez-Mazier leg.; host was *Pteronotus mesoamericanus* Smith, 1972; 1 ♂, ZUFMS-ART2373.

Identification. *Trichobius yunker* (Fig. 3D) is similar to *Trichobius caecus* Edwards, 1918. The former has two long discal setae in the tergite 7; the sternite VII may have more than five macrosetae in the posterior margin; *T. caecus* has a tiny discal seta in the tergite VII and has three or four setae in the posterior margin (Guerrero 1995).

Remarks. *Trichobius yunker* was known from Belize,



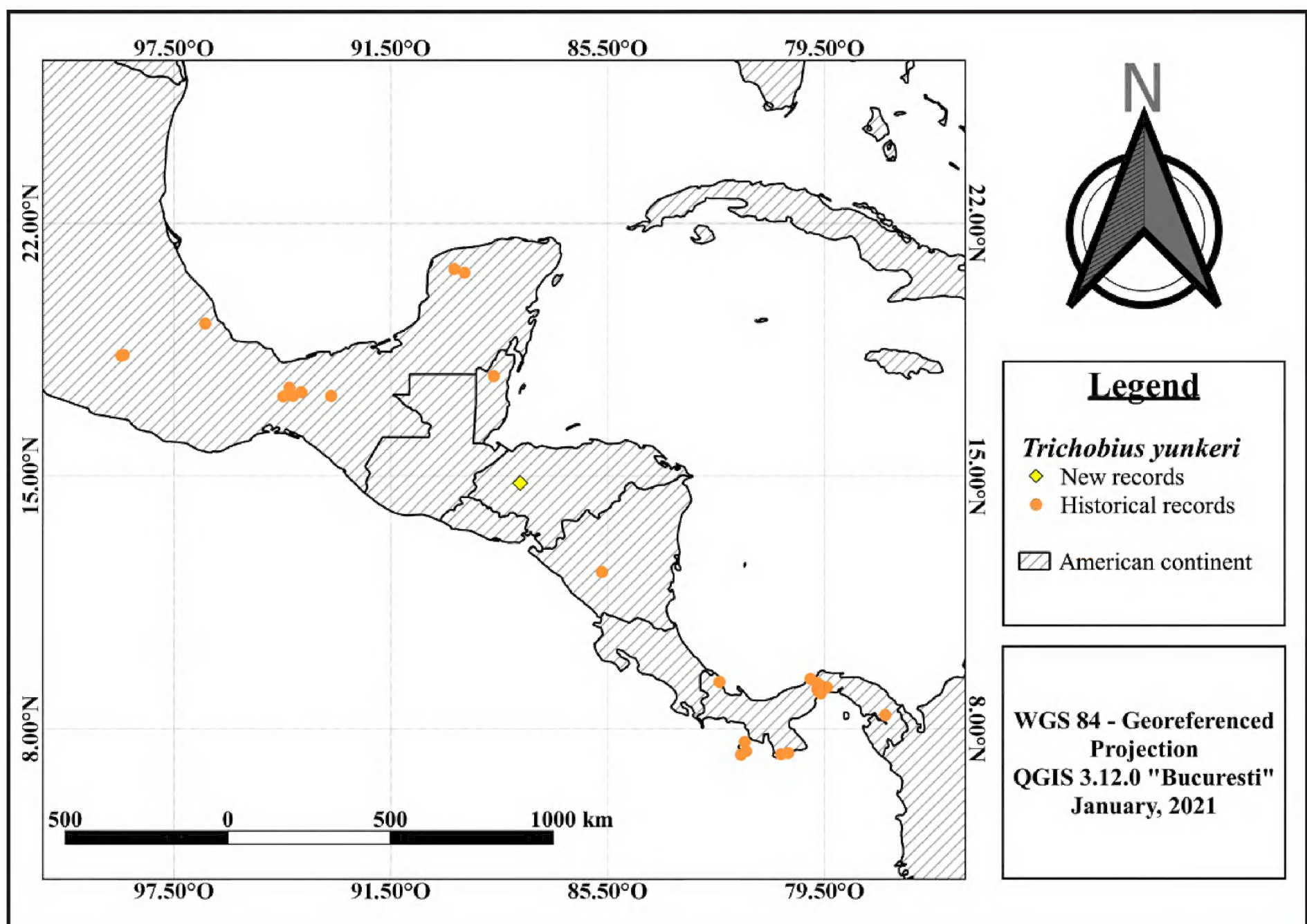


Figure 10. Historical and new records of *Trichobius yunkerii* in the Americas.

Guatemala, Mexico, Nicaragua, and Peru (Guerrero 1994b; ter Hofstede et al. 2004) (Fig. 10), but Guerrero (1994a) considered the record from Peru as doubtful. Various authors stated that subspecies of *Pteronotus parnelli* (Gray, 1843) were the hosts of *T. yunkerii* (Guerrero 1994a; ter Hofstede et al. 2004; Ramírez-Martínez et al. 2017). However, Pavan and Marroig (2016) elevated some subspecies of *P. parnelli* to full species. Therefore, it seems likely that the record for Belize (ter Hofstede et al. 2004) is from *P. mexicanus* (Miller, 1902), and for Panama, the host is *P. rubiginosus* (J.A. Wagner, 1843).

Discussion

Currently, 113 bat species have been recorded in Honduras (Turcios-Casco et al. 2020), but of these, only 36 are known to have spinturnicid mites and/or bat flies. As our data are the first records of spinturnicid mites in Honduras, it is obvious that much more effort is needed to understand this group in Central America. For example, studies in South America and Mexico led to the description of new species (Almeida et al. 2016; Morales-Malacara et al. 2020).

Honduran nycteribiid bat flies were recorded only on three species of vespertilionid bats (i.e., *Myotis nigricans*, *Myotis pilosatibialis* LaVal, 1973, and *Bauerus dubiaquercus* (Van Gelder, 1959)). However, the difficult identification of vespertilionid and molossid bats has

hindered associations of Nycteribiidae with their hosts. The genus *Basilia* potentially can be found in the other 14 species of vespertilionid bats, and species of *Hershkovitzia* should be found on *Thyroptera tricolor* Spix, 1823. Our record of *B. ortizi* on *E. furinalis* is the first for the country and is the fourth vespertilionid species known to be parasitized by *B. ortizi*.

Although streblid flies represent the majority of the bat ectoparasites that have been studied in Honduras, the intensification of new collections may considerably increase the number of species. In Honduras, streblid flies have been found only on 27 of the 59 phyllostomid species (Dick 2013; this paper). For Mormoopidae, only *P. mesoamericanus* has been reported to be parasitized by a streblid fly, and there are three more species of *Pteronotus* and *Mormoops megalophylla* (Peters, 1864) in Honduras (Turcios-Casco et al. 2020). As is the case with spinturnicid mites, there is a chance to discover undescribed species, as well as to encounter new records. Recent taxonomic reviews have found unexpected diversity of bat flies. For example, Alcantara et al. (2019) reviewed the genus *Noctiliostrebla* Wenzel, 1966, which had four previously described species, and described seven new species. *Noctiliostrebla* is known to parasitize the two species of *Noctilio* Linnaeus, 1766.

Important surveys of streblids and their hosts were carried out in Brazil (Graciolli 2020), Colombia (Marinkelle and Grose 1981; Dick et al. 2016), Panama (Wenzel

et al. 1966), Paraguay (Dick and Gettinger 2005), Peru (Guerrero 1996b; Autino et al. 2011), and Venezuela (Wenzel 1976; Guerrero 2019) (Table 1). If we consider the number of bat fly species as a variable dependent on the number of bat species, the number of bat species is a good predictor of the number of streblid species (see Dick and Gettinger 2005). For example, Figure 2 shows that Venezuela is the best-surveyed country with the greatest number of Streblidae, and that the number of bat fly species in Panama to Peru is as many as 60 per country (Fig. 2; Table 1). So far, we have increased the number of streblid flies in Honduras to 48.

To our knowledge, this is the third attempt to study bat ectoparasites in Honduras. The previous study was by Miller (2014). Seven years later, we present seven new records for Honduras: *Periglischrus iheringi*, *P. ojastii*, *Basilia ortizi*, *Aspidoptera delatorrei*, *Neotrichobius bise-tosus*, *Strebla matsoni*, and *Trichobius yunkeri*, plus the first record of Spinturnicidae for Honduras, the northernmost record of *N. bise-tosus*, and a new locality (it was previously known only from Venezuela) and a new host (*A. jamaicensis*) for *S. matsoni*. However, the ecology, behavior, and morphology of bat ectoparasites are poorly studied and understood. Among the studied sites, the Río Plátano Biosphere Reserve is the most important in Honduras for research and conservation, not only due to its high biodiversity but because it is a poorly studied. As suggested above, additional surveys in the Honduras should increase the number of species of Spinturnicidae, Nycteribiidae, and Streblidae, and even new species may be found.

Authors' Contributions

GG identified all the specimens; MATC, HDAP, EJOT, JASO, MM, and DIOM conceived and coordinated the surveys of the records; DIOM made the distribution maps. All the authors were involved in the writing of the manuscript, and read, edited, and approved the manuscript.

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